Manning Diversified Forest Products
Research Trust Fund
MDFP 06/96

Basal Bark Application of Release ™ Herbicide For Mixedwood Management

1999 – Final Report

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Pub # T/382 ISBN # 0-7732-9988-2

Acknowledgements

The authors wish to thank the Manning Diversified Forest Products Research Trust Fund, Manning Diversified Forest Products Ltd., Dow AgroSciences Canada Inc., and Ace Vegetation Control Service Ltd. for their support of this research.

Brian Johnson's efforts in conducting and collating the bird survey information and in collecting the triclopyr soil residue samples are greatly appreciated. The work of Jacques Caron and Jeff Horner in measuring crop tree growth and slash accumulation over the years is much appreciated. As are the efforts of Jim Friesen in characterizing potential experimental areas before treatment, this made site selection much more objective. You guys made the work easier and shared the interest.

Finally, the authors appreciate the input, the listening and the feedback provided by J.P. Bielech, thanks for the support and the challenges.

100-05715/

DISCLAIMER

The Manning Diversified Forest Products Trust Fund funded the study on which this report is based, in part, which is a component of the Government of Alberta's Environmental Protection and Enhancement Fund. The views, statements and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as the statements, conclusions, or opinions of members of the Manning Diversified Forest Products Research Trust Fund Committee, the Government of Alberta, or the Alberta Forest Research Advisory Council.

Introduction

The following reports establishment and results of a mixedwood stand tending research project conducted by Manning Diversified Forest Products Ltd. (MFDP.) Early results were reported previously (Anon, 1997), (Mihajlovich, 1998).

Research evaluated two stand-tending methods based on:

1. Effectiveness
2. One pass management of softwood and hardwood species
3. Safety
4. Cost
5. Impact on selected other resources

Stand-tending methods evaluated were:

1. Basal bark application of triclopyr butoxyethyl ester (Release® Silvicultural Herbicide)
2. Motor manual tending with chainsaws or brushsaws

Effect of stand tending treatments on the following parameters are reported:

1. Softwood crop tree growth
2. Slash (forest fire fuel) loading in treated areas
3. Triclopyr residues in soil near treated trees
4. Bird use of the treated area.

Project objectives

1. Assess effectiveness and safety of low volume basal bark application triclopyr butoxyethyl ester (BEE) herbicide diluted in mineral oil (1 part herbicide to 3 parts isoparaffinic mineral oil) for managing all tree species in post juvenile mixedwood sites.

2. Compare effectiveness and cost of motor manual tending (with chainsaws and brushsaws) to basal bark herbicide application for spacing and tending post juvenile mixedwood sites.

3. Qualitatively compare the following between motor manual and basal bark herbicide tending methods:
   a) short term slash loading and hence fire hazard
   b) bird use of treated, untreated, and adjacent areas.
4. Quantitatively measure the soil dissipation of triclopyr herbicide following treatment.

Materials and methods

Two regenerated cutover areas were identified in the South Hotchkiss oilfield. Cut in 1971 (25 year old stand) and 1981/82 (15 year old stand) both areas are readily accessible on high grade road. Each age of stand is uniform in aspen and white spruce size, age and density: although the stands differ from each other. Manual tending was prescribed using chain saws on the older stand, brushsaws on the younger stand. Both stands were also treated with basal bark application of triclopyr BEE diluted in isoparaffinic mineral oil. Table 1 shows treatment methods.

Table 1. Treatment methods - May 1996.

Stand Age	Treatment	Method	Concentration[1]
15 years	Herbicide	Basal bark	1:3
	Motor manual	Brushsaw	
25 years	Herbicide	Basal bark	1:3
	Motor manual	Chainsaw	

Footnotes:

1. Mixing ratio of Release™ to mineral oil.

An area one meter (1 m) in radius around crop trees was cleared of all woody competition greater than 1 m in height. Crop trees were located using a nominal two meter spacing – actual spacing ranged from one and one-half through two and one-half meters (1.5m – 2.5m.) Crop trees were selected based on species with highest preference given to white spruce and lodgepole pine, if suitable conifers were not available with prescribed spacing limits an aspen sapling was selected as the crop tree. Crop tree suitability was assessed using vigor (height:diameter ratio less than 100, greater than 35 percent live crown, and other factors); when more than one crop tree was available the largest tree (height, diameter, live crown) was selected as a crop tree.

Several areas were sampled to assess crop density and uniformity in the two stands. A number of treatment areas were laid out. Initial treatment areas were used to teach crews stand reconstruction, that is; crop tree selection based on: variable density spacing rules; crop tree health, thrift and vigor; and species priority ranking (lodgepole pine, then white spruce, then aspen.) These areas were also used as practice areas to improve work quality and production.

Once the crew became skilled in crop tree selection and use of specific treatment techniques they were moved into measured areas where productivity could be monitored.

Fixed sample plots were located in the productivity assessment area to assess the following treatment effects:
1. Crop tree response to treatment – selected trees were measured and marked prior to treatment and annually thereafter. Parameters measured were total height, diameter at the root collar, and annual height increment. Damage (abiotic and biotic) to trees was noted at each assessment.

Crop tree (white spruce sapling) measurements were transformed as follows:

- diameter was used to calculate basal area in 1996, 1997 and 1998, annual increases are presented as percent basal area increment.
- height and diameter were used to calculate mean sheath volume, annual increases are presented as percent sheath volume increment.

Mean Sheath Volume = π X d^2 X H/12 (where d is basal diameter and H is height (Newton, 1987.))

2. Slash loading was assessed on a fixed transect wherein slash was counted by diameter at point of intersection with the slash assessment transect. Slash piece counts were used to calculate quantitative fuel load using Alberta Forest Service methods (van Nest, 1984.)

3. Soil samples were taken annually from fixed locations in front of and behind treated trees. Norwest Labs analyzed samples for triclopyr BEE content.

Results and discussion

Initial densities

Average pretreatment densities of both aspen and white spruce are shown in Table 2a. Aspen densities were higher in the 25 year old stand than in the 15 year old stand. White spruce densities were much higher in the 25 year old stand than in the 15 year old stand. In both cases differences are likely due to differences in establishment practice. The blading treatment used to prepare the older site for seeding likely stimulated aspen suckering causing high initial aspen densities. Direct application of seed, followed by good seed years resulted in an overabundance of white spruce seedlings in the older stand. The younger stand was site prepared using a spot scarifier (Bräcke) which did not stimulate aspen suckering as dramatically. Also, white spruce seedlings were planted on the site giving better density control. The spot scarifier was less likely to result in reproduction from natural seedfall further contributing to more evenly spaced and less dense white spruce seedlings. Taken alone the density data are somewhat misleading -white spruce appear to dominate the older stand at 16,600 stems per hectare. These densities were due to the original reforestation treatment being blade scarification and seeding (followed by some good natural seed crops.) This resulted in dense clumps of white spruce seedlings suppressed by competition among themselves and from the adjacent large aspen.

Growth was measured as periodic basal area increment - measurement of increases in area of the base of individual trees in specified (2 year) time intervals. White spruce was merely present, not growing vigorously. This is very common in regenerated mixedwood cutovers, of this era.

Table 2a. Initial density of tree species, May 1996.

		Stems/ha (by diameter class)					
Stand age	**Species**	**0-3 cm**	**3-6 cm**	**6-9 cm**	**9-12 cm**	**12-15 cm**	**Total**
15 years	Aspen	4600	2200	2000	1400	200	10400
	White Spruce	830	0	0	0	0	830
25 years	Aspen	1600	3400	3400	1400	800	10600
	White Spruce	16600	250	25	0	0	16875

Changes in Density Following Treatment

Due to the subtlety of Release® symptoms on white spruce saplings changes in density following treatment is only reported for motor manual treatments. These data are shown in Table 2b. Aspen in the older stand had begun to express dominance among themselves, thus larger aspen were thriftier, healthier trees and were selected as crop trees; with smaller, less vigorous trees being removed to reduce competition to aspen or white spruce "crop trees". In the younger stand dominance was less clearly expressed so tending removed a more uniform distribution of aspen sapling sizes.

Table 2b. Changes in aspen density after treatment, May 1996.

Stand age	**Treatment**	**Assessment**	**Stems/ha (by diameter class)**					
(years)	**method**	**timing**	**0-3 cm**	**3-6 cm**	**6-9 cm**	**9-12 cm**	**12-15 cm**	**Total**
15 years	Brushsaw	Pre-treatment	4600	2200	2000	1400	200	10400
		Post-treatment	2000	1600	1000	800	0	5400
		Change in density	2600	600	1000	600	200	5000
25 years	Chainsaw	Pre-treatment	1600	3400	3400	1400	800	10600
		Post-treatment	0	2400	1000	1400	800	5600
		Change in density	1600	1000	2400	0	0	5000

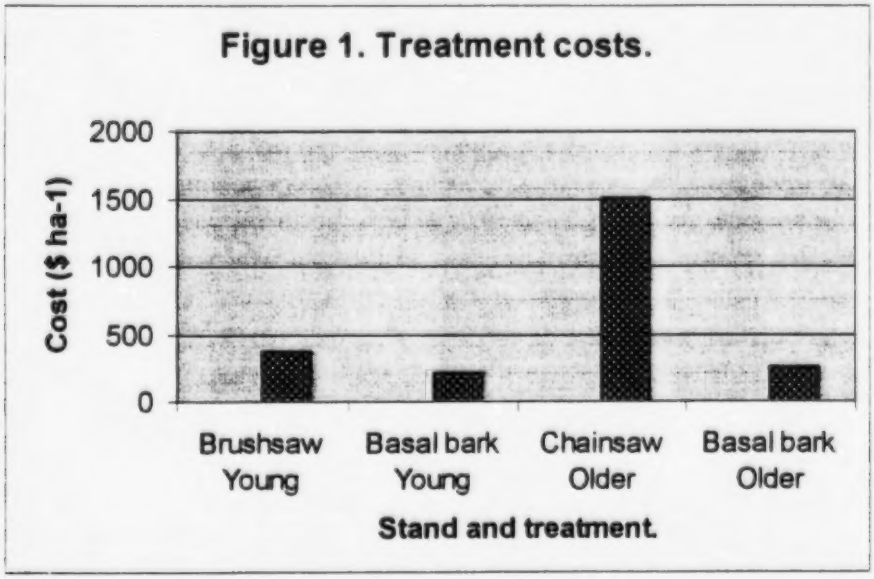
Productivity and costs

Productivity of stand tending methods is shown in Table 3 and Figure 1. Chain saw tending of the 25 year old stand was slowest with 84 person-hours required to treat one hectare (or a rate of 0.012 ha per hour), this was followed by brushsaw tending of the 15 year old stand with a productivity of 21 person-hours per hectare (0.05 ha/hr). Basal bark treatment of the older stand required 8.2 person-hours per hectare (0.12 ha/hr), whilst the younger stand required only 7.2 person-hours per hectare (0.14 ha/hr).

Table 3. Productivity and treatment costs, May 1996.

Stand age	Tending treatment	Productivity (person hours/ha)	Herbicide use (L/ha)	Cost[1] ($/ha)
15 years	Brushsaw	21.0	Not applicable	$378.00
	Basal bark herbicide	7.2	2.8	$208.00
25 years	Chainsaw	84.0	Not applicable	$1.512.00
	Basal bark herbicide	8.2	3.8	$254.00

Footnotes:
1. Based on $18/person hour (all found), $25/L for herbicide, and $1/L for mineral oil



Both motor manual tending treatments were more costly than herbicide tending, even including the cost of herbicide and oil. Costs were $1512 per hectare for chainsaw tending (25 year old stand) and $348 per hectare for brushsaw (15 year old stand). Basal bark tending of the older stand cost $254 per hectare due to lower productivity and higher herbicide use rate than treatment of the 15 year old stand ($208 per hectare.) From a cost standpoint it appears better to tend early and if that is not possible to use basal bark herbicide application.

Conifer crop tree growth response

Table 4 and Figure 2 show white spruce basal area increment, Table 5 shows sheath volume increment over the term of the study.

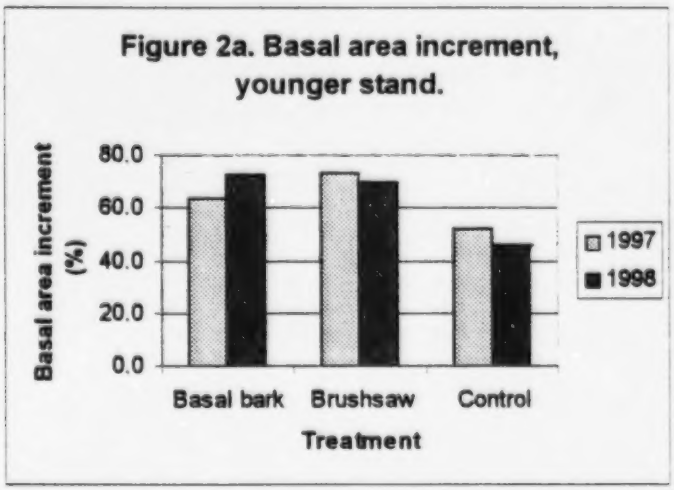
Table 4. Basal area increment, 1996 - 1998

Stand Age	Treatment Method	Basal area increment (%)[1] 1996 - 1997	1997 - 1998
15 years	Basal bark	63.4	72.8
	Brushsaw	73.3	70.1
	Control	51.9	45.7
25 years	Basal bark	26.0	9.5
	Chainsaw	27.6	10.5
	Control	22.2	9.6

Table 5. Sheath volume increment, 1996 - 1998

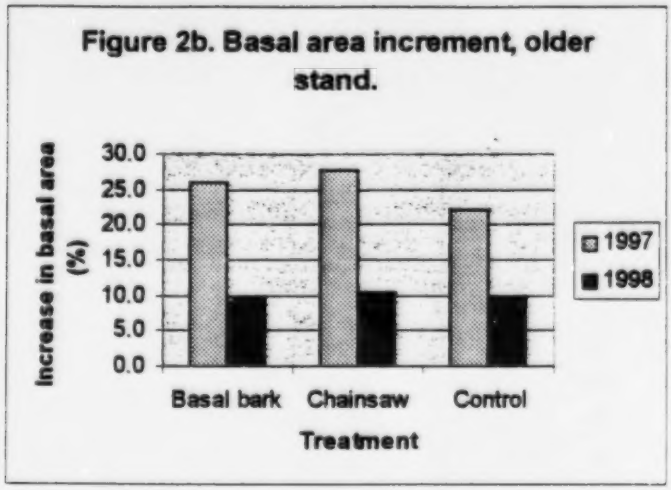
Stand Age	Treatment Method	Sheath volume increment (%)[1] 1996 - 1997	1997 - 1998
15 years	Basal bark	99.3	104.8
	Brushsaw	122.6	100.0
	Control	74.5	72.9
25 years	Basal bark	31.8	14.6
	Chainsaw	32.8	17.9
	Control	27.3	13.9

Footnote: 1. Percent response is expressed as percent of entire previous basal area or sheath volume.



Response to tending varied with motor manual treatment generally giving a greater crop tree response than basal bark herbicide application, in the older stand. In the younger stand basal bark tending resulted in greater response than manual tending two years after treatment. In the older stand response treatment was greater one year after treatment than it was two years after treatment. In the younger stand response to basal bark herbicide treatment increased in the second year after treatment, while response to motor manual tending declined.

Note that since treatments were made simultaneously crop trees in motor manual treatments have had one more growing season (the year of treatment) in which to respond than have crop trees in basal bark treated areas.



Slash loading

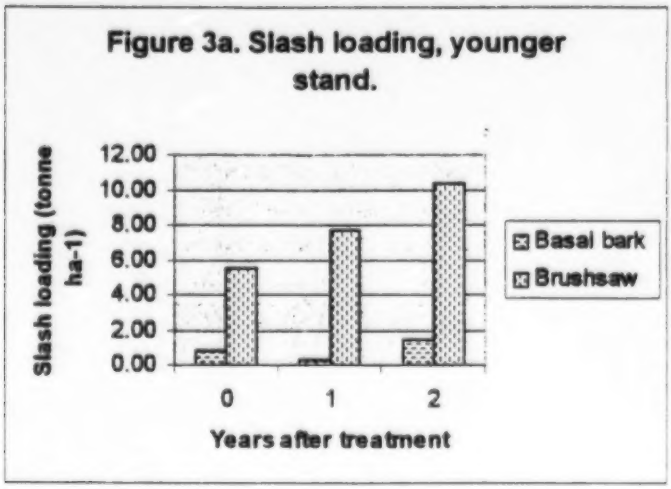
Table 6 and Figure 3 shows slash loading, by treatment, from 1996 through 1998.

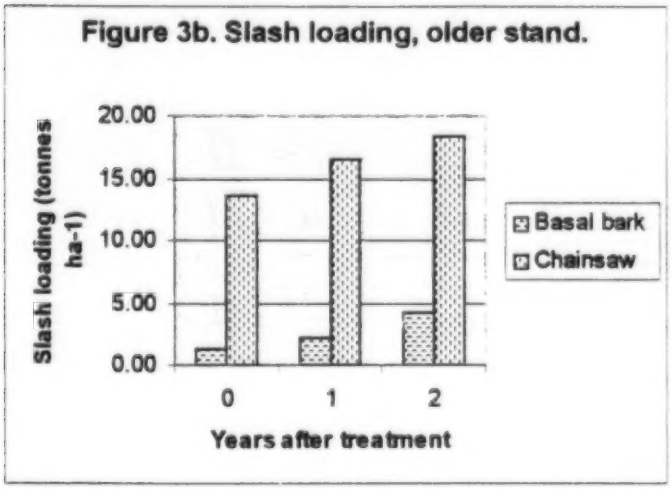
Table 6. Slash load after treatment.

Stand Age	Treatment method	Slash Loading (tonnes ha^{-1}) 1996	1997	1998
15 years	Basal bark	0.78	0.30	1.48
	Brushsaw	5.50	7.69	10.36
	Difference[1] (%)	603	2492	601
25 years	Basal bark	1.26	2.12	4.16
	Chainsaw	13.64	16.47	18.43
	Difference[1] (%)	985	679	343

Footnotes:

1. Amount by which slash load in motor manual tending exceeds herbicide slash load.





Slash loading was dramatically higher in motor manual treatments than in basal bark herbicide treatments. Slash transects were permanently marked so each assessment was of the same transect.

In the younger stand basal bark herbicide tended areas had less than 1 tonne ha^{-1} slash loading immediately after tending and one year post treatment. This burden approached 1.5 tonne ha^{-1} at two years after treatment. Brushsaw tended areas had far greater slash loads – 5.5 tonnes ha^{-1} immediately after treatment, this increased to 7.69 tonnes ha^{-1} and 10.36 tonnes ha^{-1} one and two years after treatment.

In the older stand chain saw treatment resulted in 13.6 tonnes ha^{-1} accumulation of slash immediately after treatment. This increased to 16.47 tonnes ha^{-1} two years after treatment and to 18.43 tonne ha^{-1} by three years after treatment. Basal bark herbicide tending resulted in 1.26, 2.12 and 4.16 tonnes ha^{-1} immediately, one and two years after treatment respectively.

Increases in slash accumulation in motor manual tended areas between years are due to settling of slash resulting in more large pieces being tallied in the second assessment than in the first assessment. In basal bark tended areas treated stems area fall down and become part of the slash burden more gradually; resulting in the gradual increases in slash burden shown.

Triclopyr residues in soil

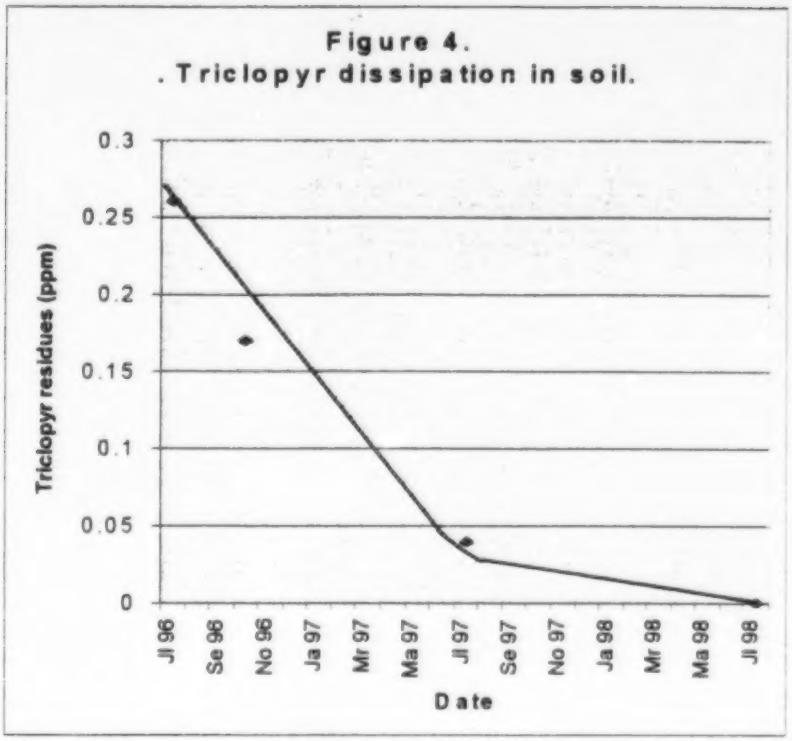


Table 7 and Figure 4 show triclopyr dissipation data to disappearance. Herbicide residues were only found behind treated stems. In 1996 average residue levels behind target trees were 0.21 parts per million (ppm) one month after treatment decreasing to 0.17 ppm by October. By July 1997 average triclopyr residue levels behind crop trees fell to 0.035 ppm. By July 1998 there were no detectable triclopyr residues found. Detection limits for triclopyr (ester and acid) using this analytic method are 0.5 parts per billion (ppb.) Calculated half-life of triclopyr in this study is approximately 64 days.

Table 7. Triclopyr residues, following tending.

Sample timing	Position (versus treated stem)	
	In front	*Behind*
June, 1996	ND[1]	0.26 ppm
October, 1996	ND[1]	0.17 ppm
July, 1997	ND[1]	0.035ppm
July, 1998	ND[1]	ND[1]

Footnotes:

1. ND - Not detectable, limit of detection 0.5 ppb.

Bird use of treated areas

Results of bird use surveys, by treatment and season of survey, over the course of the study are summarized in Table 8. Survey results did not appear related to treatment type or years after treatment. The most prominent trend was fall surveys resulting in more observations and individual bird counts than summer surveys, which yielded observations, and individual bird counts than spring surveys. In previous reports efforts have been made to draw more substantive conclusions from bird survey data through use of diversity indices, these did not appreciable clarify survey results. In addition, surveys were recompiled based on bird species with marked preferences for specific habitat types in an effort to identify some treatment related impact; again no clear trend in bird use was evident. Small treatment areas and/or low survey frequencies may have jeopardized bird use survey accuracy.

A list of bird species encountered over the course of this study is given in Table 9.

Table 8a. Summary - spring bird use surveys of treated areas.

Stand Age		1996		1997		1998	
(years)	Treatment	Obs[1]	Birds[2]	Obs[1]	Birds[2]	Obs[1]	Birds[2]
15 year old stand	Basal bark	4	7	5	6	6	7
	Brushsaw	2	2	6	7	4	4
	Control	3	5	7	8	4	8
25 year old stand	Basal bark	3	3	7	7	9	9
	Chainsaw	5	5	3	3	4	4
	Control	3	3	4	4	5	5

Table 8b. Summary - summer bird use surveys of treated areas.

Stand Age		1996		1997		1998	
(years)	Treatment	Obs[1]	Birds[2]	Obs[1]	Birds[2]	Obs[1]	Birds[2]
15 year old stand	Basal bark	3	3	8	8	6	6
	Brushsaw	3	3	4	4	4	4
	Control	4	6	4	5	4	8
25 year old stand	Basal bark	3	5	8	8	7	9
	Chainsaw	5	5	3	3	4	4
	Control	5	5	4	4	5	6

Table 8c. Summary - fall bird use surveys of treated areas.

Stand Age		1996		1997		1998	
(years)	Treatment	Obs[1]	Birds[2]	Obs[1]	Birds[2]	Obs[1]	Birds[2]
15 year old stand	Basal bark	2	2	5	8	3	5
	Brushsaw	2	5	4	11	3	5
	Control	2	6	4	4	3	3
25 year old stand	Basal bark	2	4	4	7	3	4
	Chainsaw	3	18	3	5	3	14
	Control	2	5	4	7	4	9

Footnotes: 1. Number of observations.

2. Total number of birds observed.

Table 9. Bird list - all treatments, by year and season.

Bird species (in order of frequency)	Spring			Summer			Fall			Winter	
	1996	1997	1998	1996	1997	1998	1996	1997	1998	1996	1997
Gray jay	X	X	X	X	X	X	X	X	X	X	X
Raven	X	X	X	X	X	X	X	X	X	X	X
Ruffed grouse	X	X	X	X	X	X	X	X	X	X	X
Dark-eyed junco	X	X	X	X	X	X	X	X	X		
Robin	X	X	X	X	X	X	X	X	X		
White-throated sparrow	X	X	X	X	X	X		X	X		
Least flycatcher	X	X		X	X	X					
Hairy woodpecker	X	X	X		X	X	X	X	X	X	X
Black-capped chickadee		X	X	X	X	X	X	X	X	X	X
Downy woodpecker	X			X			X			X	
Vesper sparrow	X			X	X	X					
Northern flicker	X	X	X	X	X	X		X	X		
Savannah sparrow	X	X	X	X	X	X		X			
Northern three-toed woodpecker		X	X		X	X		X	X		
Orange-crowned warbler		X	X		X	X					
Chipping sparrow			X		X	X		X			
Swainson's thrush		X	X		X	X					
American kestrel	X	X	X	X	X			X			
Tennessee warbler	X		X	X							
Ovenbird			X		X	X					
Swamp sparrow	X	X			X	X					
White-crowned sparrow					X	X			X		
Spruce grouse		X	X	X		X			X	X	X
Red-tailed hawk	X						X	X			
Merlin	X				X						
Boreal chickadee	X							X		X	
Marsh hawk	X	X	X						X		
Red-winged blackbird	X										
Cedar waxwing				X				X			
American redstart	X										
Red-breasted nuthatch			X	X					X		
Traill's flycatcher	X		X		X						
Horned lark	X							X			
Canada goose	X										
Snow bunting	X								X	X	
Pine grosbeak									X		
Yellow-bellied sapsucker			X		X						
Red-eyed vireo			X		X						
Solitary vireo			X								
Wilson's warbler			X								
Killdeer			X								
Song sparrow			X								
Warbling vireo			X								
Yellow warbler			X								
Tree swallow			X								
Rough-legged hawk									X		
Yellow throat			X								
Mallard	X										
Green-winged teal	X										
Lesser yellowlegs				X		X					
Great gray owl		X	X						X		X
Magpie	X										
Magnolia warbler	X										
Brewer's blackbird		X									
Ruby-crowned kinglet		X			X						
Common snipe		X	X		X						
Solitary sandpiper					X			X			
Great horned owl											X

Conclusions

1. Regardless of stand age basal bark herbicide tending cost much less than motor manual tending.

2. a) All treatments gave an increase in crop tree growth.
   b) Crop tree growth responded more rapidly to motor manual treatment than to basal bark herbicide treatment.
   c) The younger stand showed a relatively greater response to tending than the older stand.
   d) Response of the younger stand to tending appears to be sustained longer than response of the older stand.

3. a) Slash (fuel) loading following treatment was less in the younger stand than in the older stand.
   b) Slash (fuel) loading was far less following basal bark tending than following motor manual tending, regardless of stand age at treatment.
   c) Slash loading in all treatments continued to increase over the course of the assessment period.

4. a) Triclopyr (herbicide) residues were only found behind treated trees.
   b) Triclopyr residues declined to non-detectable levels by two growing seasons after treatment.
   c) Calculated half-life of triclopyr in the study area was 64 days.

5. Bird use surveys did not identify any treatment-linked impact on bird use of treated areas.

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